CRITICAL HABITATS OF CARIBOU (RANGIFER TARANDUS CARIBOU) IN THE MOUNTAINS OF SOUTHERN BRITISH COLUMBIA

Ministry of Environment and Parks
Nelson, B.C.

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INTRODUCTION

Mountain caribou (Rangifer tarandus caribou), in contrast to many other northern ungulates, move to high elevation ranges in late-winter to feed on arboreal lichens (Alectoria spp., Bryoria spp.). The knowledge that caribou spend the late-winter on high elevation ranges has led to general acceptance that high-elevation subalpine forests are the most critical habitats for mountain caribou (Edwards and Ritcey 1959; Freddy 1974; Bloomfield 1979; Russell et al. 1982). In most cases, caribou were reported to use low elevation, old-growth forests during early-winter (November to January). However, caribou are difficult to locate in dense forests and most conclusions were based on few sightings. This obvious visibility bias made it difficult to assess the extent of use of low elevation forests and their relative importance to mountain caribou. Early-winter has been cited as a critical period for caribou since deep soft snow confines caribou to low elevations where food is limited (T. Antifeau, pers. comm.; Russell et al. 1982).

Using radio location data, we identified habitats used by mountain caribou during each season. We also collected data to assess the relative hardship experienced by caribou in the early- and late-winter periods. Information on seasonal changes in caribou mobility and food availability was necessary in determining critical habitats. We have proposed an expansion of the currently accepted designation of critical habitat for mountain caribou and discuss the aspects important to management.

STUDY AREA

The study area lies within the Interior Wet Belt and encompasses the drainage of the Columbia River between Revelstoke and Mica, B.C. Elevations range from 460 m (1500 ft.) on the Columbia River to 3050 m (10 000 ft.) at the highest peaks. The main Columbia Valley runs north-south and side slopes average 35%. Tributaries run predominantly east-west with somewhat steeper side slopes (45-60%). Many large rolling plateaus occur both east and west of the Columbia at about 1830 m (6000 ft.) elevations. These plateaus are predominantly within the Engelmann Spruce-Subalpine Fir Parkland forest zone (ESSP) (Krajina 1969). Upper slopes from 1370 m (4500 ft.) to 1830 m (6000 ft.) are within the Engelmann Spruce-Subalpine Fir (ESSF) zone and have continuous forest cover with increasing canopy closure at lower elevations. Below 1370 m (4500') the forest cover is predominantly western redcedar (Thuja plicata) and western hemlock (Tsuga heterophylla) within the Interior Cedar Hemlock (ICH) zone. These forests have denser canopies and less undergrowth than the spruce-fir types. The area below 570 m (1880 ft.) was completely cleared between 1978 and 1983, for reservoir development, and flooding began in October 1983.

Arboreal lichen abundance and availability varies with forest type and snowpack. In low elevation cedar-hemlock forests little lichen grows beneath the canopy. Lichens only become available to caribou when trees or branches fall. In spruce-fir forests lichens grow down to 3 m on standing trees

(Stevenson 1979) and are most abundant at 7 m (Simpson et al. 1985). Caribou, therefore, required a 2- to 3-m snow platform to reach lichens in spruce-fir forests.

METHODS

Fifteen caribou, six male and nine female, were fitted with radio collars. From one to six animals carried functioning radio collars from 1981 to 1984. Animals were relocated from the air every two weeks on average (Simpson et al. 1985). Radio location data for the 4 years were combined to describe seasonal habitat use by caribou.

During two potentially limiting periods, early- and late-winter, we followed small groups of caribou to gather comparative information on mobility and food availability. We tracked 10 groups a total distance of 11.4 km between November 24 and December 5, 1982, and five groups for 15.2 km between April 5 and April 14, 1983. The mean elevation of tracking areas was 1050 m (3400 ft.) in early-winter and 1930 m (6300 ft.) in late-winter. Data were collected on animal movements, snow conditions and feeding sign within measured 50-m intervals along the tracks.

We counted the number of paces taken by caribou and measured their sinking depths in the snow every 50 m. We also counted the number of beds, urinations and pellet groups, estimated the number of animals from tracks, and recorded the occurrence of single file tracks within each 50-m segment.

We measured the snow depth frequently in early-winter. During late-winter, when the snow was very deep, we dug pits to check snow depth twice in each tracking area. The lift provided caribou by the snow pack was calculated by subtracting their sinking depths from the snow depth.

We counted the number and recorded the type of feeding sites within each 50-m segment. Each tree or shrub found along the tracks, where there was evidence of feeding, was recorded as a distinct site. We estimated the intensity of use of lichen feeding sites by the amount of trampling in the snow around each. A walk-by was rated 1; stop and turn, 2; walk around, 3; and trampled, 4. The caribou's habit of stripping the leaves from shrub stems allowed us to estimate visually the percentage of leaves eaten. We estimated lichen loads on branches on a five-point scale ranging from nil, less than 1% cover; to sparse, 1-5% cover; moderate, 6-25% cover; abundant, 26-50% cover; and extensive, 51-100% cover (Bloomfield 1979). Lichen remaining at each feeding site (residual lichen) was compared to lichen on similar unused sites in the same area (available lichen) to get a visual estimate of the amount removed by feeding caribou. Available lichen was difficult to estimate in early-winter because comparable unused sites, such as unused windfallen branches, were generally not available for comparison. In those cases, we examined the fallen branches for remnants of lichen and estimated lichen loads high in the forest canopy from which the lichen-bearing branch had fallen. Unused sites close to tracks (<10 m) where food was within reach of caribou were counted and recorded as available but unused for each 50-m interval.

In late-winter, when caribou groups were larger, we purposely selected small (x = 3.9 anim.) groups to follow so that data were comparable to early-winter (x = 2.5 anim./group). Small groups also facilitated estimates based on tracks, such as feeding intensity. We had difficulty reaching tracking areas after some heavy snowfalls in early-winter, so our data did not represent the most severe conditions experienced by caribou at that time.

RESULTS

Seasonally important habitats used by mountain caribou in the study area were identified using locations of radio-collared animals (Fig. 1). In early-winter (November 1-January 15), caribou were found in cedar-hemlock forest (ICH) and the low portion of the spruce-fir forest (ESSF). In late-winter (January 16-April 15), caribou used alpine parkland (ESSP) and the upper portion of the spruce-fir forest. In spring, caribou again moved to low elevations within the cedar-hemlock forest. Caribou were seldom sighted in immature forest (20-60 years old) and radio-collared animals were never located there. Immature forests were characterized by closed canopies of close growing young trees with little light penetration and almost no undergrowth. Neither lichen nor ground forage was available to caribou in immature forested areas.

In early-winter, snow accumulated steadily and caribou frequently sank to the ground in the light snow. Sinking depths were significantly greater, caribou took more paces to travel 50 m (Table 1) and in-line travel was more frequent in early-winter (X^2 =125, $p<.001$, Table 2). Assuming equal urination and defecation rates, caribou moved three times farther during equivalent time intervals in early-winter, compared to late-winter (X^2 =11, $p<.01$, Table 2). Radio-tracking data also showed that although caribou remained within smaller areas in early-winter, the distance walked each day was greater than in late-winter (Simpson et al. 1985).

Lichen on standing trees was above the reach of caribou in early-winter and most feeding was on shrubs and litterfall lichen (Table 3). The availability of ground forage (shrubs and herbs) decreased as they became covered in snow. Caribou encountered 55 feeding sites/km in late-winter, compared to 6/km in early-winter (Table 2). Not only were feeding sites widely scattered in early-winter, but there was also less food at each site. Both lichen remaining after feeding (residual) and estimated quantities available at lichen feeding sites were much lower in early-winter (Table 1). In late-winter, caribou could feed higher in the forest canopy where lichen was more abundant because the deep snowpack provided lift (Table 1). Caribou rarely ignored food within reach in early-winter while many available sites were passed by in late-winter (Table 2). Windfallen trees, although occurring infrequently (Table 3), probably contributed the greatest biomass to the caribou's early-winter diet. Animals remained near windfallen trees longer than in other areas. Eleven of 13 beds and 28% of all defecations found in early-winter were within 100 m of windfallen trees. Trampling around windfallen trees indicated that caribou fed more intensively at windfalls than at other feeding sites in early- or late-winter. Feeding intensity averaged 3.2 at 14 windfallen trees compared to 2.2 and 2.3 at all feeding sites in early- and late-winter (Table 1).

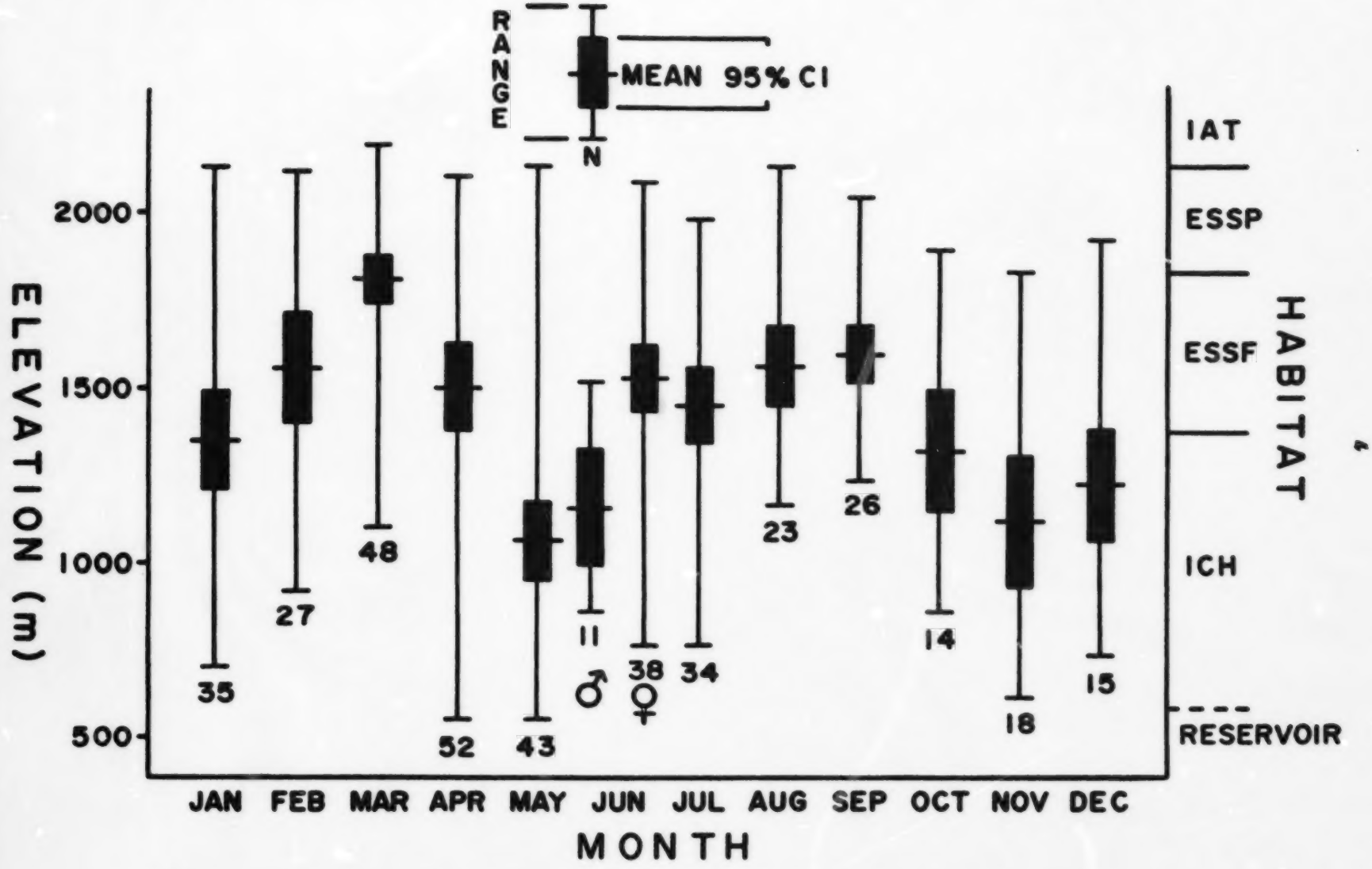

Figure 1. Monthly elevations of radio collared caribou. Cows and bulls differed significantly in June.

Table 1. Comparison of snow characteristics and lichen availability within 50-m intervals while tracking caribou in early- and late-winter

	Early-winter			Late-winter			
Variable	mean	SE	N	mean	SE	N	signif
Sinking depth (cm)	37	1.0	174	32	0.6	297	*
No. paces	81	1.0	228	67	0.7	304	*
Snow depth (cm)	74	2.1	175	280	8.6	14	*
Snow lift (cm)	37	2.0	174	248	2.0	297	*
Available lichen	2.5	0.2	39	3.6	0.1	255	*
Residual lichen	1.8	0.1	52	3.2	0.1	255	*
Feeding intensity	2.2	0.1	85	2.3	0.1	255	*

* t-test $p<.001$

Table 2. Frequency of occurrence of caribou sign indicating the rate and difficulty of movement and the number of feeding sites found in early- and late-winter

Caribou sign	Early-winter		Late-winter	
	Total	No./anim./km	Total	No./anim./km
Single file tracks	142		70	
Not single file	50		234	
Beds	13	0.5	190	3.2
Urinations	86	3.0	544	9.2
Pellet groups	48	1.7	312	5.3
Feeding sites	171	6.0	3249	54.8
Available but unused feeding sites	16		2595	

Table 3. Frequency of use of different types of feeding sites in early-winter and late-winter

Feed type	Early-winter		Late-winter	
	Total	%	Total	%
Paxystima myrsinites	74	43		
Litterfall lichen	51	30	2	
Windfallen trees (lichen)	14	8		
Standing trees (lichen)	16	9	3247	100
Herbs	11	6		
Other shrubs	5	3		
Total	171	99	3249	100

Caribou also fed heavily on lichen from felled trees in active logging areas. Nine of ten active logging areas that we visited were used by caribou during the winters of 1981 or 1982. Further, the animals were frequently seen by the loggers during the day and tended to ignore the heavy equipment operating around them. During logging operations, the loggers removed fallen trees quickly to avoid losing them under new snow. Branches were stripped and pushed over the edge of landings, and stems were sorted and stacked. Once the trees were skidded to landings, most lichen was again unavailable to caribou. The resultant short-term availability of lichen may, in part, explain why caribou moved into logging areas during active logging. We had two reliable reports of caribou poaching involving three and six animals respectively, in or around logging areas. Both reports, however,were long after the fact so we were unable to verify them by searching for physical evidence.

By spring, caribou were in poor physical condition. Their ribs, back and hip bones protruded noticeably. Caribou moved down into the valley bottoms as soon as new green vegetation became available, usually by late April. In June, pregnant cows moved to snow-covered areas above 1370 m (4500 ft.) to calve. Ground forage was covered by compacted snow and most arboreal lichen was out of reach. Feces crude protein of four samples collected from three radio-collared cows in June and early July averaged 12%, much lower than the norm for other species in spring (Fig. 2). Cows with new calves remained in such areas for 2 to 4 weeks. Although their mobility was excellent, food resources near the calving sites were severely limited. Two of six calves born to radio-collared cows died within 1 month of birth.

Twelve of 14 natural caribou mortalities occurred between January and May. Eight died in snow avalanches, one died of starvation in January, following a neck injury, and one was killed by a wolverine in April. Two others were found dead, one being eaten by a grizzly in May and the other intact in February. Two bulls died when they locked antlers in October 1983. Five of 15 radio-collared animals died within 1 year of capture and were included among the above.

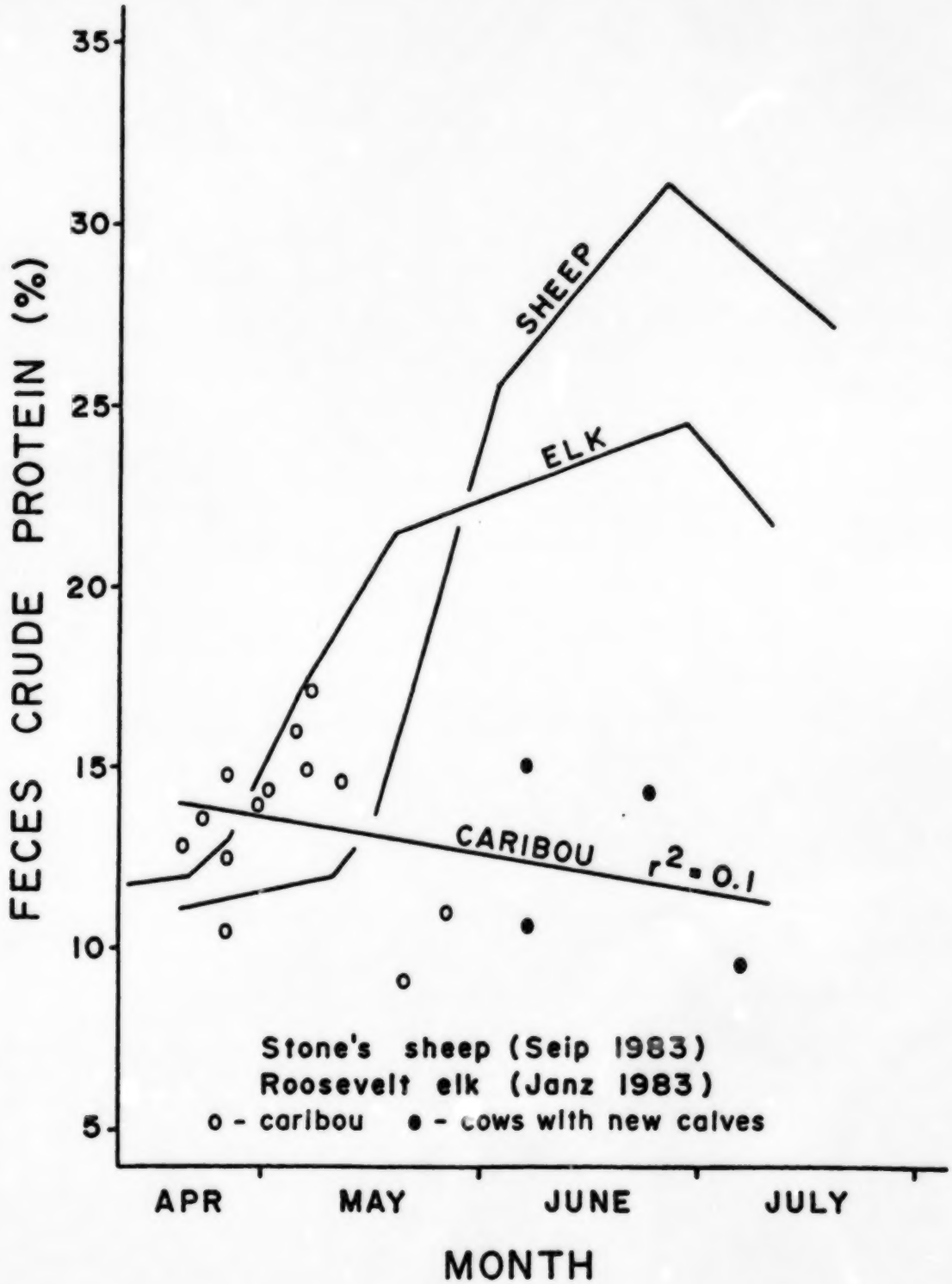

FIG. 2. Changes in feces crude protein for caribou and two other ungulates during spring green-up.

DISCUSSION

Information on snow sinking depths, paces taken to move 50 m and single-file movement all indicated that caribou experienced a much greater mobility stress in early-winter than in late-winter. Parker (1983) showed that the energy cost of movement for ungulates in snow increased exponentially with increased sinking depths. Deep, soft snow and greater sinking depths made movement most costly when location of dispersed and limited food resources required greater movement. Most caribou, except bulls, began winter in good condition and although few animals starved, their physical condition declined rapidly in early-winter. Two recorded mortalities in early-winter resulted from starvation following accidental injuries (this study; Seip and Hebert 1985).

Caribou were attracted to active logging areas in early-winter to exploit the abundant food and easy mobility on cleared skid trails. Caribou avoided areas of human activity at all other times of the year. The use of active logging areas where caribou were vulnerable to harassment and possibly poaching suggests that poor mobility restricted food availability so severely that caribou preferred to use what would otherwise have been unfavourable areas. Although logging continued through the winter, few caribou used logging slashes in late-winter when the snowpack hardened and alternate high elevation ranges became available.

Several characteristics of low elevation cedar-hemlock forest were important to caribou in early-winter. Dense coniferous forests intercept snowfall and contribute to greater compaction of the snow that reaches the ground (Pruitt 1970). Total snowfall was less and thaws occurred more frequently at low elevations. Ground forage was available longer and caribou could move more easily in the shallow, compacted snow found in low elevation cedar-hemlock forests. Windfallen lichen-bearing trees and lichen litterfall were important food sources for caribou in early-winter (Table 3). Windfallen trees occur most frequently and lichen litterfall is heaviest in decadent over-mature (old-growth) forests (Stevenson 1978). The extensive movement of caribou during early-winter and because they stopped at windfalls suggest that they were searching the forest for windfalls. Their use of active logging areas also suggests that fallen trees were a preferred food source. The best natural habitat for mountain caribou in early-winter is old-growth forest, in valley bottoms and lower slopes, where windfalls occur frequently, litterfall is heavy, movement is easier and ground forage remains available longer.

Lichen forage was abundant in late-winter primarily because, with the lift by the snowpack, caribou could feed over 5 m high on standing trees (Table 1). The frequent occurrence of feeding sites along tracks and caribou's slow movement suggested that they could easily obtain adequate quantities of food. Although few starved, the condition of animals in spring and fecal nitrogen analysis (Fig. 2) suggested that lichen was a poor quality food. Stevenson (1978) reviewed six studies on the nutritional value of arboreal lichens and found the protein content ($\bar{x}$ 5%) to be below the minimum required by deer in winter. Caribou probably continued to lose weight in late-winter, but more slowly than in early-winter, because less energy was required to obtain lichens. Factors that increase the effort required by

caribou to obtain lichens or cause animals to cross steep slopes probably increase their weight loss or cause accidental mortalities. The best late-winter ranges for mountain caribou are large contiguous areas of open-canopy, old-growth forest on ridge tops and upper slopes where lichen is abundant, the snowpack provides lift to reach lichens and the avalanche hazard is low.

Spring range was important for caribou to recover weight lost over winter and to prepare cows for the heavy demands of lactation when they moved to food-deficient areas for calving. Spring ranges were also heavily used by moose (Alces alces) and bears (Ursus americanus, U. arctos). Three moose and two caribou were believed killed by predators on spring ranges (Simpson et al. 1985). Seip and Hebert (1985) also documented two predator kills of adult caribou in early-summer. The concentration of predators in the valley bottoms suggests that most calves would be lost if cows remained on spring ranges for calving.

Despite the avoidance of high risk habitats by cows, one-third of the calves born to radio-collared cows died shortly after birth. Seip and Hebert (1984) documented the starvation of a cow and calf in July. Early calf mortality, based on summer cow/calf ratios, averaged 25% in this study (Simpson et al. 1985) and 66% in four other studies (Fuller and Keith 1981; Ritcey and Jury 1984; Scott and Servheen 1984; Seip and Hebert 1984). The absence of predators in calving habitats strongly suggests that these early mortalities were related to the strength of the calf at birth and to nutrition of the cows. Food available to pregnant cows and their physical condition affected calf survival after birth in barren ground caribou (Dauphine 1976). The poor condition of caribou after winter, the short duration of high quality spring feeding for cows and the lack of food in calving areas may all contribute to poor calf survival.

Caribou suffered high natural mortality among adults. Five of 15 collared caribou died within 1 year of collaring. Seip and Hebert (1985) also lost four of 16 collared caribou within 1 year. Accidents, predation and starvation caused most of the mortalities in late-winter or spring. Although starvation was not common, poor nutrition of pregnant cows may have contributed to poor calf survival. The limited reproductive success of caribou coupled with high natural mortality could explain the rapid decline of caribou in southern British Columbia. Human activities such as habitat alteration (logging and fires), winter recreation (snowmobiling and skiing) and hunting (poaching), which have minor impacts on other species of deer, may have severe impacts on caribou populations.

The requirement of caribou for old-growth forest in both early- and late-winter puts them in direct conflict with forest management. Current forest management goals emphasize removal of old-growth and long-term harvest schedules that will maintain younger, more productive forests. The impact of logging on caribou habitat depends on the seasonal use that caribou make of harvested areas. In the Kamloops and Cariboo regions of British Columbia, plateaus ,which occur between 1300 m (4500 ft.) and 1825 m (6000 ft.), form the primary late-winter range of caribou (Ritcey 1976; Beets and Russell 1976). These areas are also economically attractive for logging. In our study area, plateaus, where most caribou move in late-winter, occur above 1825 m (6000 ft.) in alpine parkland and are not considered harvestable.

Habitat protection efforts in southern British Columbia have been directed mainly to late-winter ranges of mountain caribou. In a recent discussion paper on caribou-logging conflicts, only areas above 1675 m (5500 ft.) were considered important to caribou (Ministry of Forests and Ministry of Environment 1982). In our area, low elevation, early-winter habitats have been reduced by logging and reservoir development and, in our opinion, are as important to caribou as late-winter ranges. To develop meaningful guidelines to protect caribou ranges, all potentially limiting habitats must be considered. The characteristics of each seasonal habitat important to caribou must be described and the extent to which each characteristic is compatible or incompatible with forest harvesting must be identified. Once guidelines are developed, they must be applied with specific local knowledge so that regional differences in caribou habitat selection and forest harvest strategies are considered.

Although long-term harvests will eliminate caribou winter foods, several aspects of cut-leave harvesting temporarily assist in providing food for caribou in early-winter. In addition to providing freshly felled trees, harvesting allows wind penetration of the canopy and thus windfalls along cut-block margins (Alexander 1974). Lichen litterfall also increases in such areas. Production of herbs and shrubs in cutover areas increases their availability to caribou in early-winter and spring. Once all mature timber is removed and replaced with immature forest, such sites would not support caribou in any season. Since caribou feed exclusively on lichen on standing trees in late-winter, any cutting on late-winter ranges will reduce the forage available to caribou and potentially reduce their reproductive success.

A secondary, but important, aspect of logging is the access that it creates for hunters and recreationists to otherwise remote caribou ranges. Unrestricted use of caribou ranges by people may cause animals to move into steeper areas where mobility and food supplies are poor and the potential for avalanches is greater. Direct human-induced mortality, resulting from access, is difficult to document and is not separable from losses due to habitat destruction (Bergerud 1978; Bloomfield 1979). Six caribou were illegally killed by deer/elk hunters in the southern Kootenays in the fall of 1983 (R. Hoar, pers. comm.). Because of increasing access and the lack of wariness of caribou, poaching could be a serious problem associated with logging. The direct impacts of access can potentially affect caribou populations more quickly and dramatically than habitat alterations.

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